THE IMPLEMENTATION OF ADVANCED SOLAR ARRAY TECHNOLOGY IN FUTURE NASA MISSIONS

Michael F. Piszczor, Thomas W. Kerslake, David J. Hoffman
NASA Glenn, 21000 Brookpark Rd., Cleveland, OH 44135, USA
&
David Murphy, Brian Spence and Michael Eskenazi
AEC-Able Engineering Co., 7200 Hollister, Goleta, CA 93117, USA

Advanced solar array technology is expected to be critical in achieving the mission goals on many future NASA space flight programs. Current PV cell development programs offer significant potential and performance improvements. However, in order to achieve the performance improvements promised by these devices, new solar array structures must be designed and developed to accommodate these new PV cell technologies. This paper will address the use of advanced solar array technology in future NASA space missions and specifically look at how newer solar cell technologies impact solar array designs and overall power system performance.

REVIEW ABSTRACT

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Correspondence: Michael F. Piszczor, Jr.
NASA Glenn Research, MS302-1, 21000 Brookpark Rd., Cleveland, OH 44135, USA
Phone: 216-433-2237, Fax: 216-433-6106, E-Mail: michael.piszczor@grc.nasa.gov

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Michael F. Piszczor, Thomas W. Kerslake & David J. Hoffman
NASA Glenn, 21000 Brookpark Rd., Cleveland, OH 44135, USA
&
Steve White, Mark Douglas, Brian Spence and P. Alan Jones
AEC-Able Engineering Co., 7200 Hollister, Goleta, CA 93117, USA
Phone: 805-685-2262, Fax: 805-685-1369, E-mail: dmurphy@aec-able.com

Advanced solar array technology is expected to be critical in achieving the mission goals on many future NASA space flight programs. Over the years, significant improvements have been made in solar cell technology, specifically in achieving higher cell efficiencies, to improve array performance. During this time, solar array/panel technology has changed only slightly. Current photovoltaic cell development programs, specifically in the areas of thin film, concentrator and novel high efficiency devices, offer significant potential and performance improvements. However, in order to utilize these new technologies and achieve the performance improvements promised by these devices, new solar array structures must be designed and developed to accommodate these new PV cell technologies. This paper will address the use of advanced solar array technology in future NASA space missions and specifically look at how newer solar cell technologies impact solar array designs.

A solar array system study was previously conducted by AEC-Able Engineering under NASA funding to look at advanced solar array technology for various NASA missions. Preliminary results of this study have been previously presented. This paper will present additions made to the study since that time and provide a more comprehensive analysis of the results and the implications, at the system/array level, of using advanced photovoltaic technology. The paper will specifically review not only the benefits of using advanced technology under specific mission requirements, but also quantify the impacts of cell technology at the array level. A summary of the different missions and the requirements for those missions is given in Table I.

The results of the study will also be analyzed and quantified to identify key photovoltaic cell and blanket component technologies that drive or severely impact system level array performance. These results will then be presented to guide PV cell/blanket technology research in an effort to optimize not just cell level, but total solar array performance. Recommendations will then be made for future PV cell research, based on these overall mission and system requirements.

Table I. NASA mission types and requirements addressed under the study.

Requirements	LEO	MEO	GEO	PowerSail	SEP Transfer Tug	Interplanetary
EOL Power Class	3 kW	10 kW	20 kW	100 kW	250 kW	10 kW
Orbit (circular)	1000 km, 90°	8000 km, 0°	36,000 km circular	1,000 km, 0°	Spiral out (twice) from 400 km to GEO in 9 months	0.7 to 5 A.U.
Life	7 years	7 years	15 years	7 years	1.5 years	7 years
Temperature Range	120C to -100C	110C to -140C	100C to -180C	120C to -100C	130C to -180C	180C at 0.7 A.U., & 220C at 5 A.U.
Array configuration	two fixed wing systems	two fixed wing systems	two fixed wing systems	Free-Flyer	two fixed wing systems	two fixed wing systems
Stowage Volume	fit within 3.75 m fairing on sidewall	fit within 3.75 m fairing on sidewall	fit within 3.75 m fairing on sidewall	fit within 3.75 m to 5 m fairing > 50 kW/m^3 goal	fit within 3.75 m to 5 m fairing > 50 kW/m^3 goal	fit within 3.75 m fairing on sidewall
Circuit Characteristics, EOL Voltage (<5% loss) and Amperage	Vmp=30 V, Isc<2.5A	Vmp=30 V, Isc<2.5 A	Vmp=100 V, Isc<2.5A	Vmp=300 V, Isc<2.5A	Vmp=300 V, Isc<2.5A	Vmp=100 V, Isc<2.5 A
ESD	Operation without degradation	Operation without degradation	Operation without degradation	Operation without degradation	Operation without degradation	Operation without degradation
Deployed Stiffness	0.25 Hz	0.10 Hz	0.05 Hz	0.01 Hz (decoupled)	0.02 Hz	0.10 Hz
Deployed Loading	.01 g	.01 g	.007 g	0.003	0.002	.01 g
Stowed Stiffness	40 Hz	40 Hz	30 Hz	30 Hz	30 Hz	40 Hz
Stowed Strength	20 g	20 g	20 g	20 g	20 g	20 g
Acoustic Loading	147 dB (OASPL)	147 dB (OASPL)	147 dB (OASPL)	147 dB (OASPL)	147 dB (OASPL)	147 dB (OASPL)

Combinations	LEO	MEO	GEO	PowerSail	SEP Transfer Tug	Interplanetary
MJ Configurations (3 efficiency levels)	Aurora, UF, SR, RP, ARP-CS, ARP-SLA	Aurora, UF, SR, RP, ARP-CS, ARP-SLA	Aurora, UF, SR, RP, ARP-CS, ARP-SLA	Aurora, UF, SR, RP, ARP-CS, ARP-SLA	Aurora, UF, SR, RP, ARP-CS, ARP-SLA	Aurora, UF, SR, RP, ARP-CS, ARP-SLA
TF Configurations (3 efficiency levels, 2 areal densities)	Aurora, UF, SR	Aurora, UF, SR	Aurora, UF, SR	Aurora, UF, SR	Aurora, UF, SR	Aurora, UF, SR